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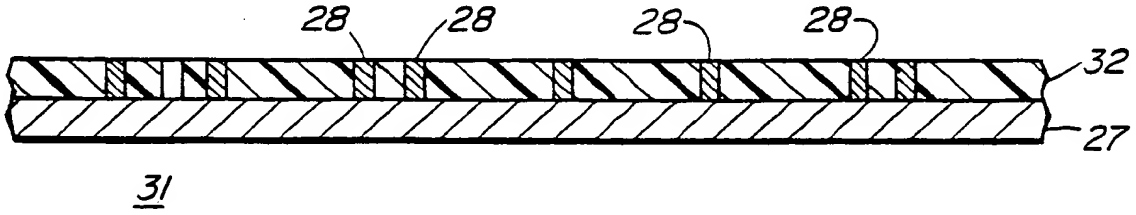
(54) Title: METHOD OF MAKING AN IMPRESSING TOOL



(57) Abstract

A method of making an impressing tool used for making impressions in molded circuit boards and the like. A planar metal backing plate (27) is covered with a relatively thin layer of a thermoplastic material (32). A laser beam is used to cut a pattern into the thermoplastic material, right down to the backing plate. A plating step is performed in which a metal (28) (e.g. chromium or nickel) is plated to the backing plate, according to the pattern in the thermoplastic layer. In other words, the thermoplastic layer acts as a mask. The thermoplastic layer (32) is removed by an etching step and the tool is complete. In a second embodiment, a photographic process is used in place of the laser operation.

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METHOD OF MAKING AN IMPRESSING TOOL

This invention relates generally to impressing and more particularly to a tool used for impressing.

Background of the Invention

For the purposes of this document, impressing will be considered to be the act of causing relief in an otherwise flat surface. One application for impressing is in the field of electrical circuit boards sometimes referred to as printed circuit boards or PCBs. An example of a molded circuit board is depicted in U.S. patent No. 4,604,678 dated August 5, 1986 by George R. Hagner entitled "Circuit Board with High Density Electrical Tracers".

Summary of the Invention

The present invention is directed to a tool that facilitates the impressing or the making of grooves or recesses on a molded circuit board. The tool begins with a platen of steel approximately ¼ inch thick. To that platen is bonded a layer of plastic approximately 15 mils thick. A laser beam is then used to trace the desired pattern on the plastic; in the process of using the laser beam the laser beam burns away the plastic down to the steel platen. The assembly is then placed into an electrolytic plating tank. In the plating process, the plastic performs the function of a mask. Plated material builds up through the cut pattern in the plastic, level to the top of the plastic. A material such as nickel cobalt or chromium is deposited. Next, in an etching step, the plastic is stripped off. The impressing tool is then complete, with the steel platen as a backing and with protrusions being composed of nickel cobalt or chromium. This assembly is then placed in a press and is used for hot stamping.

Stated in other terms, the present invention is a method of making a tool for impressing, the method character-ized by the steps of: making a predetermined

pattern in a first layer of a multi-layer assembly such that the pattern passes completely through the first layer to reveal a second layer; plating the assembly such that the pattern becomes filled with a plating material extending approximately the thickness of the first layer; and stripping off the first layer.

Stated in still other terms, the present invention is a method of making a tool for impressing, the method comprising the steps of: applying a planar layer of plastic to a planar metal backing plate to form a multi-layer assembly; making a pattern in the plastic layer, down to the metal backing plate; plating the assembly such that the pattern becomes filled with a plating material bonded to the metal backing plate and extending approximately to be flush with the outer surface of the plastic layer; and stripping off the plastic layer.

Stated in yet other terms, the present invention is a method of making a tool for impressing, the method characterized by the steps of: applying a planar layer of a photosensitive material to a planar metal plate to form a two layer assembly: cutting a pattern into the photosensitive material, with photographic techniques, down to the metal plate; electroplating the assembly such that the pattern becomes filled with a metallic plating material bonded to the plate and extending to be approximately flush with the outer surface of the photosensitive layer; and stripping away the photosensitive layer.

Stated in yet other terms the present invention is a method of making a tool for impressing, the method characterized by the steps of: applying a planar layer of a thermoplastic material to a planar metal backing plate to form a two layer assembly; cutting a pattern into the thermoplastic material with a laser, down to the metal backing plate; electroplating the assembly such that the pattern becomes filled with a metallic plating material bonded to the backing plate and extending to be approximately flush with the outer surface of the

thermoplastic layer; and stripping away the thermoplastic layer.

Stated in yet other terms, the present invention is a tool for impressing characterized by: a backing plate of a first material; a second material, deposited in relief on the first material, in a predetermined pattern.

Stated in still other terms, the present invention is a tool for impressing, having a backing plate of a first material and a second material, deposited in relief on the first material, in a predetermined pattern, the tool characterized by being made according to the following steps: cutting a predetermined pattern into a first layer of a multilayer assembly such that the pattern passes completely through the first layer to reveal a second layer;

plating the assembly such that the pattern becomes filled with a plating material extending approximately the thickness of the first layer and bonded to the second layer; and stripping away the first layer whereby the tool is revealed with the second layer being the backing plate and the plating material being the second material, deposited in relief.

Brief Description of the Drawings

The invention will now be described in more detail with reference to the accompanying drawings, wherein like parts in each of the several figures are identified by the same reference characters, and wherein;

Figure 1 is a plan view of a not untypical molded circuit board;

Figure 2 is a simplified cross-section of an impressing tool constructed according to the teachings of the present invention;

Figure 3 is a simplified cross-section of the impressing tool of the present invention in an initial stage of construction;

Figure 4 is similar to Figure 3 but shows the pattern etched during the construction of the tool;

Figure 5 is similar to Figure 4 but additionally shows material deposited in the pattern; and

Figure 6 is a simplified cross-section of the impressing tool of the present invention in an initial stage of construction (second embodiment);

Figure 7 is an enlarged view of part of Figure 1 showing more detail;

Figure 8 is a cross-sectional view of Figure 7, taken through the section lines 8-8 in Figure 7;

Figure 9 is a simplified cross-section of an impressing tool of the present invention in an initial stage of construction (third embodiment);

Figure 10 is similar to Figure 9 but shows a subsequent step in the process;

Figure 11 is similar to Figure 10 but shows a subsequent step in the process;

Figure 12 is similar to Figure 11 but shows a subsequent step in the process; and

Figure 13 is a simplified isometric view, partly in section, of an impressing tool constructed according to the teachings of the present invention.

Detailed Description

Figure 1 depicts a not untypical molded circuit board 20 constructed with a tool of the present invention. Circuit board 20 is made of a thermoplastic material 21 (example Polyethersulfone) and comprises holes 22, recess pads 23, and grooves 24 interconnecting pads 23 and holes 22. The impressing tool of the present invention is used to make the recesses 23, the grooves 24 and the holes 22.

Figure 2 depicts impressing tool 26 of the present invention in simplified cross-section. Note that if tool 26 were to be used to make the pattern shown on circuit board 20 in Figure 1, then the plan view of tool 26 would match that of the pads 23, grooves 24, and holes 22 of Figure 1. Tool 26 comprises a platen 27 made of hygrade steel that has projections 28 as shown in the cross-section of Figure 2.

It should be noted that none of the Figures are to scale. In Figure 2, platen 27 is approximately ¼ inch thick although its thickness is not critical. The projections 28 are approximately 15 mils high and approximately 7 mils wide.

Figure 3 depicts tool 26 (in cross-section) in an initial stage of construction and is referred to as assembly 31. Assembly 31 comprises platen 27, as previously described, and bonded thereto (by example using Eastman No. 910 adhesive) a plastic layer 32 approximately 15 mils thick. As stated previously, the thickness of platen 27 is not critical. The thickness of the plastic layer 32 is preferably the same dimension as the height of the protrusions 28 in Figure 2. A laser beam is then used to trace the desired pattern on the plastic; in the process it burns away the plastic down to the steel of platen 27 as depicted by the recesses 25. This is depicted in more detail in Figure 4 to which attention is directed.

The next step in the construction of impressing tool 26 is to place the assembly 31 of Figure 4 into an electrolytic plating tank (containing, for example nickel-cobalt salt solution). The platen 27 is fastened to an electrical cathode. In the plating process that follows, the plastic layer 32 performs the function of a mask. The material builds up through the cut pattern (i.e. fills the recesses 25) in the plastic layer 32 level to the top of the plastic 32. In one preferred embodiment the material deposited is nickel cobalt (approximately 98% nickel and 2% cobalt). Chromium or certain other materials could also be used. After the plating process, assembly 31 has the appearance as shown in Figure 5 wherein the platen 27 carries the plastic layer 32 as well as projections 28 as depicted in Figure 5.

In an etching step (using, for example propapyhene 22GF20), plastic layer 32 is stripped off (i.e. removed) and impressing tool 26 is then finished and appears as that shown in Figure 2. In use, impressing tool 26 is placed in

a press and is used for hot stamping. In the stamping process, both the die (i.e. tool 26) and the plastic 21 are heated. The plastic 21 is heated to approximately 350° F and the die or impressing tool 26 itself is heated to 350° F to 400° F temperature.

Material 21 is typically 20% milled glass filled.

A second, and preferred way, of making tool 26 will now be described, making reference to Figure 6. Figure 6 depicts tool 26 (in cross-section) in an initial stage of construction and is referred to as assembly 31a. Assembly 31a comprises platen 27a (identical to platen 27 of Figures 2 to 5), and bonded thereto a photosensitive film 32a. Film 32a can be up to approximately 0.060 inches thick, but is typically 0.015 inches to 0.020 inches thick. Product No. Fanton 306 aqueous developable photoresist manufactured by Armstrong World Industries is the preferred film for layer 32a. The desired pattern for board 20 (Figure 1) in the form of a "mask" (not shown) is placed on top of assembly 31a (i.e. next to layer 32a) and exposed to light. This is the same type of process that is used to make the patterns in printed circuit boards (PCBs).

Next, the mask is removed and the film 32a is developed, thereby revealing the pattern of the mask. The developing is continued until the exposed pattern has penetrated completely through layer 32a and platen 27a is just exposed.

The remaining steps in making tool 26, according to this preferred method, are as before; i.e. continue with the steps of Figures 4 and 5, and the end result is as shown in Figure 2.

If it is desired to form the holes 22 (of Figure 1) at the same time as the grooves 24 (of Figure 1) then extra steps are required in the production of impressing tool 26. The version of tool 26 with the "hole feature" will be referred to as impressing tool 26b.

Figure 7 depicts a portion of molded circuit board 20 (from Figure 1) showing a hole 22 in more detail. Figure

8 is a cross-sectional view of Figure 7 through the section lines 8-8. From Figure 7 and 8 it can be seen that hole 22 is comprised of three main parts. Hole 22 is comprised of annular ring 22b on one surface of board 20, annular ring 22c on an opposite surface of board 20, and a cylindrical opening or hole 22a passing completely through board 20 from annular ring 22b to annular ring 22c.

Figure 9 depicts impressing tool 26b (in cross-section) in an initial stage of construction and is referred to as assembly 31b. In Figure 9, assembly 31b is at the same stage of construction as was assembly 31 in Figure 5. That is, assembly 31b of Figure 9 comprises steel platen 27b (approximately ¼ inch thick) carrying a plastic layer 32b as well as projections 28a and 28b. As in Figure 5, projections 28a and 28b are nickel cobalt deposited in a plating process.

Note that while assembly 31 of Figure 5 had only one type (or size) of projections, namely projections 28, assembly 31b of Figure 9 has two types (or sizes) of projections, namely projections 28a and projection 28b. It should be noted at this point, that projections 28a will serve to form the grooves 24 (in Figure 1) while projections 28b will serve to form the annular rings 22b and 22c of holes 22; projections 28a are the same size as projections 28 of Figures 2 and 5.

At this stage of the formation of tool 26b, assembly 31b (of Figure 9) is identical to assembly 31 (of Figure 5) except for the inclusion of projection 28b.

Figure 10 shows assembly 31b with a second plastic layer 33b placed overtop of layer 32b as depicted. The thickness of layer 33b will depend upon the thickness of circuit board 20 (Figure 1). In one preferred method of making circuit board 20, two dies are used simultaneously. One die is placed on one side of board 20 and a second die is placed on the opposite side. As a result, any projection used to form hole 22a need go only half way through the thickness of board 20; a corresponding projection will be

coming from the opposite side. In other words, the combined thickness of layers 32b and 33b should be approximately one half of the thickness of circuit board 20 of Figure 1.

Figure 11 shows assembly 31b with layer 33b and a recess 25b cut away by a laser beam, similar to making recesses 25 in Figure 4. The only difference in Figure 11 is that recess 25b is a cylindrical recess or hole, whereas recess 25 (of Figure 4) was a groove or a track.

Figure 12 depicts assembly 31b with layer 33b after a plating process has occurred and nickel cobalt has been deposited to form projection 28c. This plating process is the same as the one used to form projections 28 in Figure 5.

The final step is to remove plastic layers 32b and 33b by an etching step. This leaves the final impressing tool 26b as shown by an isometric view in Figure 13, partially in section.

Note that projections 28a serve to form grooves 24 in circuit board 20 of Figure 1. Projection 28b serves to form annular ring 22b (Figure 8), and projection 28c serves to form one half of hole 22a (Figure 8).

As with tool 26, tool 26b can alternatively be formed by a photographic process. In that case, plastic layers 32b and 33b would be replaced by photosensitive film as was explained in connection with Figure 6.

CLAIMS:

1. A method of making a tool for impressing, said method characterized by the steps of:

making a predetermined pattern in a first layer of a multi-layer assembly such that said pattern passes completely through said first layer to reveal a second layer;

plating said assembly such that said pattern becomes filled with a plating material extending approximately the thickness of said first layer; and

removing said first layer.

2. The method of claim 1, wherein said first layer is a thermoplastic material and said second material is a metal.

3. The method of claim 1 wherein said first layer is polypropolene and said second material is steel.

4. The method of claim 1, 2, or 3 wherein said making a predetermined pattern is performed by a laser beam.

5. The method of claim 1, 2, or 3 wherein said plating material is a metal.

6. The method of claim 1, 2, or 3 wherein said plating material is chromium.

7. The method of claim 1, 2, or 3 wherein said plating material is nickel cobalt.

8. The method of claim 1, 2, or 3 wherein said plating material is approximately 15 mils thick.

9. The method of claim 1, 2, or 3 wherein said step of removing is accomplished by etching.

10. The method of claim 1 wherein said first layer is a photosensitive material.

11. The method of claim 1 or 10 wherein said making a predetermined pattern is performed by a photographic process.

12. A method of making a tool for impressing, said method comprising the steps of:

applying a planar layer of plastic to a planar metal backing plate to form a multi-layer assembly;

making a pattern in said plastic layer, down to said metal backing plate;

plating said assembly such that said pattern becomes filled with a plating material bonded to said metal backing plate and extending approximately to be flush with the outer surface of said plastic layer; and

removing said plastic layer.

13. The method of claim 12 wherein said plastic is a thermoplastic material.

14. The method of claim 13 wherein said metal backing plate is steel.

15. The method of claim 12, 13 or 14 wherein said making a pattern is performed by a laser beam.

16. The method of claim 12, 13 or 14 wherein said plating material is a metal.

17. The method of claim 12, 13 or 14 wherein said making a pattern is performed by a laser beam and wherein said plating material is a metal.

18. The method of claim 12, 13 or 14 wherein said plating material is chromium.

19. The method of claim 12, 13 or 14 wherein said plating material is nickel cobalt.

20. The method of claim 12, 13 or 14 wherein said plating material is nickel.

21. The method of claim 12, 13 or 14 wherein said layer of plastic is approximately 15 mils thick.

22. The method of claim 12, 13 or 14 wherein said step of removing is accomplished by etching.

23. The method of claim 12 wherein said plastic is a photosensitive plastic.

24. The method of claim 23 wherein said metal backing plate is steel.

25. The method of claim 12, 23 or 24 wherein said step of making a pattern is performed by a photographic process.

26. The method of claim 12, 23 or 24 wherein said plating material is nickel cobalt.

27. The method of claim 12, 23 or 24 wherein said plastic layer is approximately 15 mils thick.

28. A method of making a tool for impressing, said method characterized by the steps of:

applying a planar layer of a photosensitive material to a planar metal plate to form a two layer assembly:

cutting a pattern into said photosensitive material, with photographic techniques, down to said metal plate;

electroplating said assembly such that said pattern becomes filled with a metallic plating material bonded to said plate and extending to be approximately flush with the outer surface of said photosensitive layer; and

removing said photosensitive layer.

29. The method of claim 28 wherein said metal plate is made of steel and said metallic plating material is nickel cobalt.

30. A method of making a tool for impressing, said method characterized by the steps of:

applying a planar layer of a thermoplastic material to a planar metal backing plate to form a two layer assembly;

cutting a pattern into said thermoplastic material with a laser, down to said metal backing plate;

electroplating said assembly such that said pattern becomes filled with a metallic plating material bonded to said backing plate and extending to be approximately flush with the outer surface of said thermoplastic layer; and

removing said thermoplastic layer.

31. The method of claim 30 wherein said thermoplastic material is polypropolene, said metal backing plate is made of steel, and said metallic plating material is nickel cobalt.

32. A tool for impressing characterized by:

a backing plate of a first material;

a second material, deposited in relief on said first material, in a predetermined pattern.

33. The tool of claim 32 wherein said first and second materials are metals.

34. A tool for impressing, said tool having a backing plate of a first material and said tool having a second material, deposited in relief on said first material, in a predetermined pattern, said tool characterized by being made according to the following steps:

cutting a predetermined pattern into a first layer of a multilayer assembly such that said pattern passes completely through said first layer to reveal a second layer;

plating said assembly such that said pattern becomes filled with a plating material extending approximately the thickness of said first layer and bonded to said second layer; and

stripping away said first layer whereby said tool is revealed with said second layer being said backing plate and said plating material being said second material, deposited in relief.

35. A method of making a tool for impressing, said method comprising the steps of:

making a predetermined pattern in a first layer of a multi-layer assembly such that said pattern passes completely through said first layer to reveal a second layer;

plating said assembly in a first plating operation such that said pattern becomes filled with first plating material extending approximately the thickness of said first layer;

applying an outer layer, overtop said first layer, and making a predetermined pattern in said outer layer such that said pattern passes completely through said outer layer to reveal said first plating material;

plating said assembly in a second plating operation such that said pattern in said outer layer becomes

filled with second plating material extending approximately the thickness of said outer layer; and

removing said first layer and said outer layer.

36. The method of claim 35 wherein said first layer is a thermoplastic material and said second layer is a metal.

37. The method of claim 36 wherein said outer layer is a thermoplastic material.

38. The method of claim 36 wherein said outer layer is a photosensitive material.

39. The method of claim 35 wherein said first layer is a photosensitive material and said second layer is a metal.

40. The method of claim 39 wherein said outer layer is a thermoplastic material.

41. The method of claim 39 wherein said outer layer is a photosensitive material.

42. The method of claim 36, 37, 38, 39, 40, or 41 wherein said metal is steel.

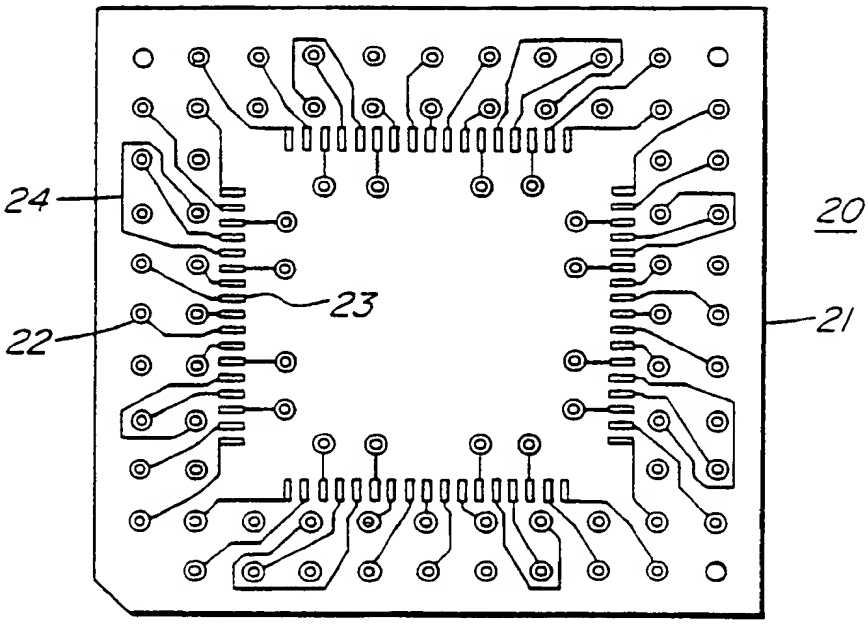

FIG. 1

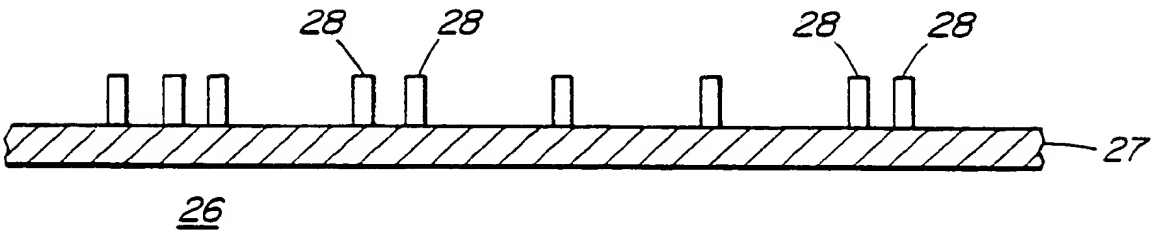

FIG. 2

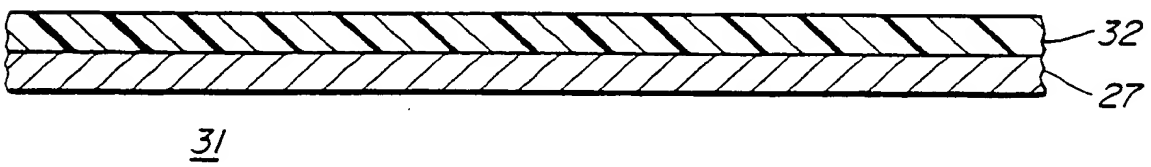

FIG. 3

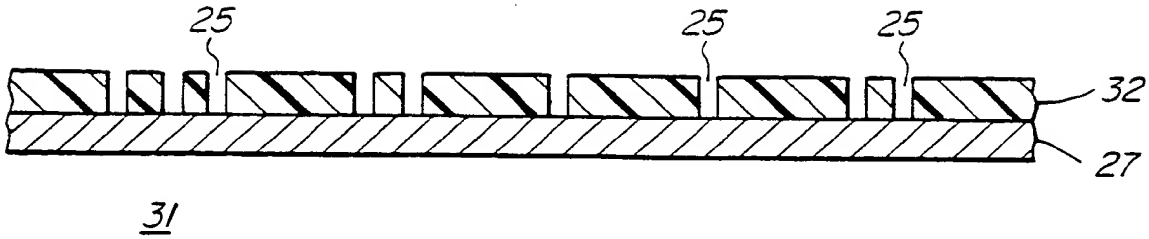

FIG. 4

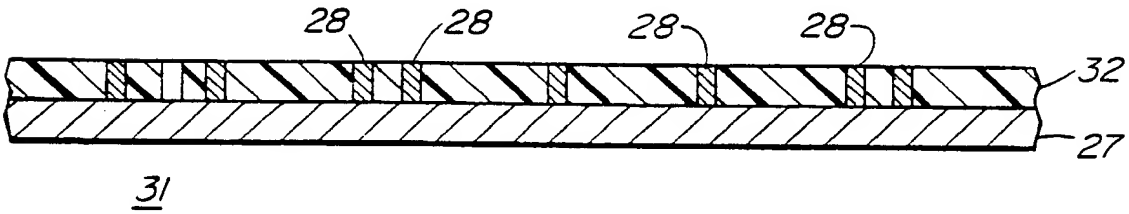

FIG. 5

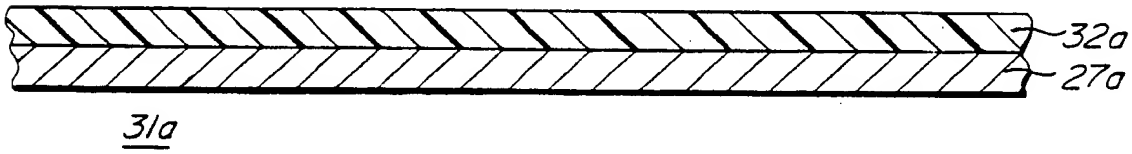

FIG. 6

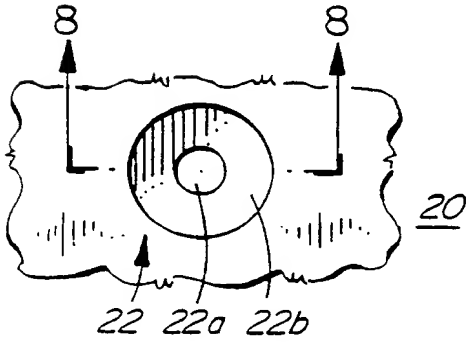

FIG. 7

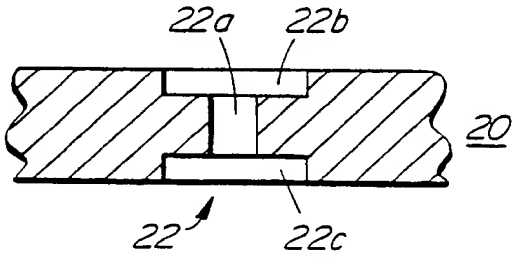

FIG. 8

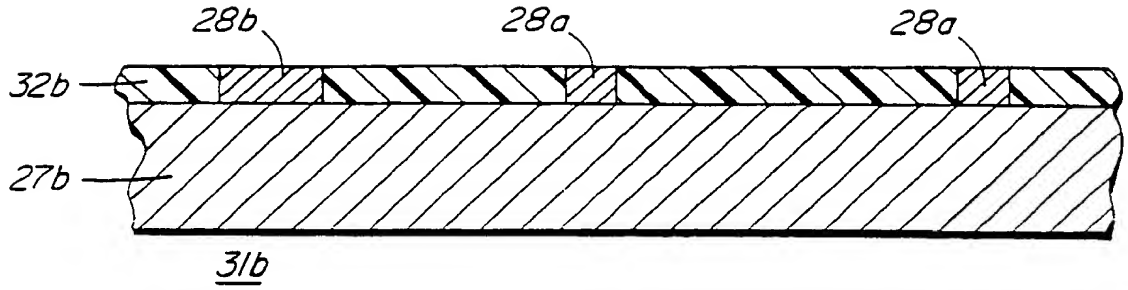

FIG. 9

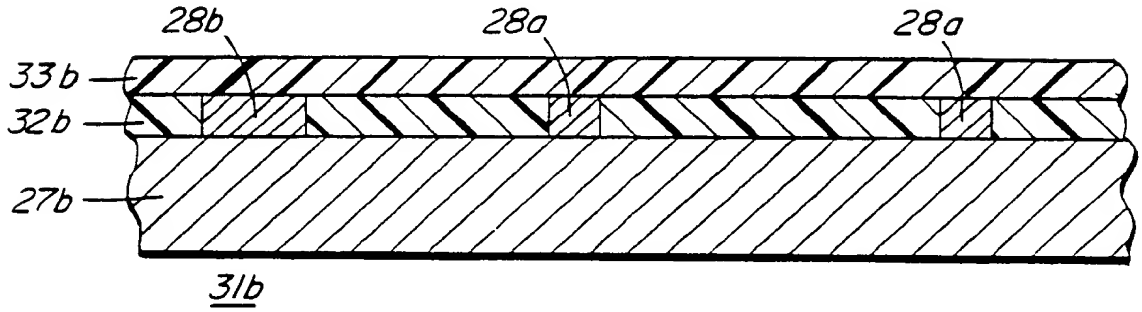

FIG. 10

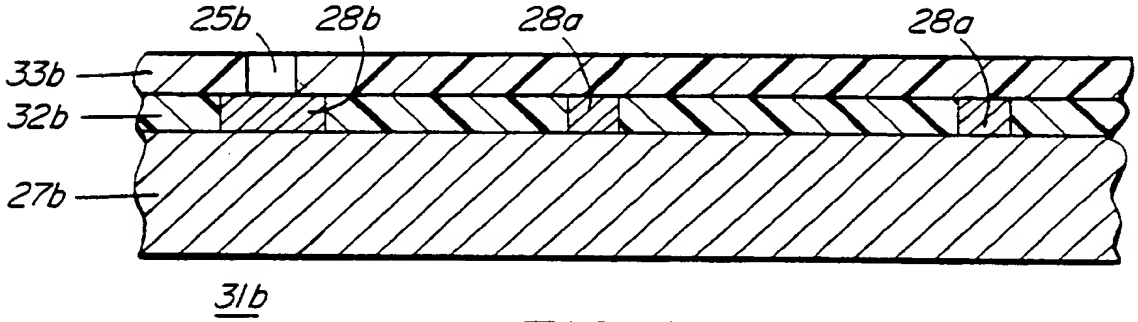

FIG. 11

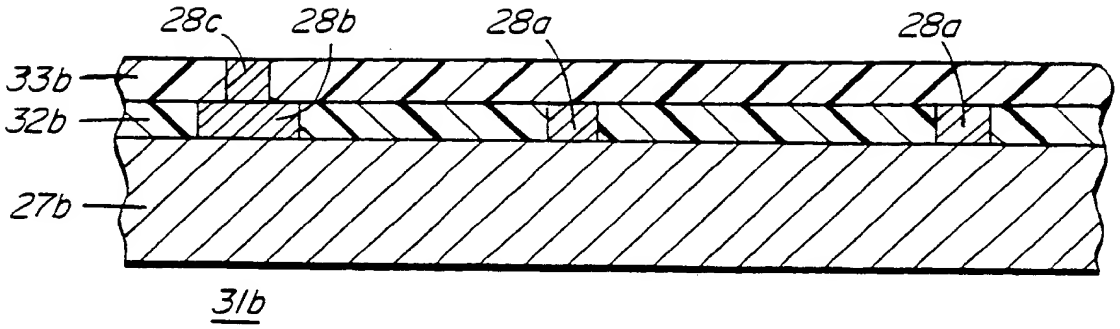

FIG. 12

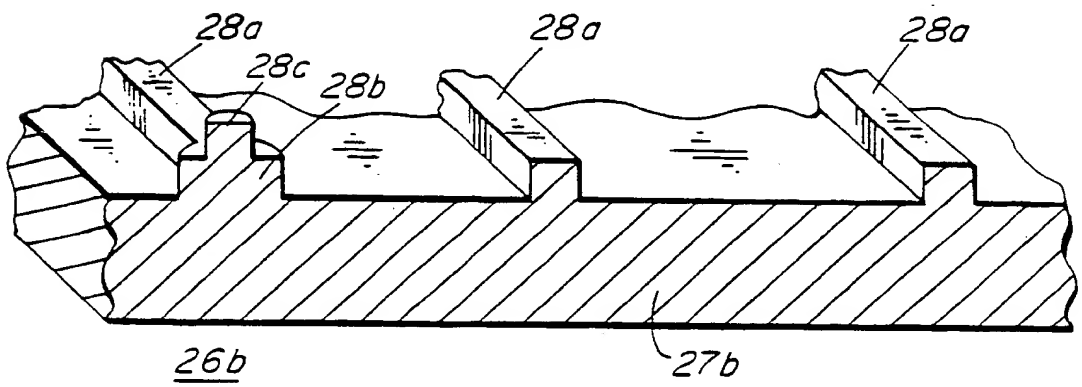

FIG. 13

INTERNATIONAL SEARCH REPORT

International Application No PCT/CA 90/00112

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 H05K3/00 ; C25D5/02

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
Int.Cl. 5	H05K ; C25D

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category °	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No.[13]
X	FR,A,2553710 (EDUARD HUECK) 26 April 1985 see page 1, lines 1 - 24 see page 4, line 22 - page 6, line 1; figure 1	1, 5, 6, 9, 32, 33
Y		2-4, 7, 12-20, 22, 26, 29, 30
Y		34-42
A		3, 24, 31

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° Special categories of cited documents : [10]

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
03 JULY 1990	30. 07. 90
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	MES L.A.

Form PCT/ISA/210 (second sheet) (January 1985)

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category °	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
Y	EP,A,106977 (INTERNATIONAL BUSINESS MACHINES CORP.) 02 May 1984 see claims 1, 3, 4, 12; figure 1	2-4, 12-20, 22, 26, 30, 34-42
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A	US,A,4769309 (KING ET. AL.) 06 September 1988 see column 4, line 46 - column 5, line 25; figures 3-9	1, 9-11, 28
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Y	CHEMICAL ABSTRACTS, vol. 97, no. 24, December 1982 Columbus, Ohio, USA GRILIKHES ET. AL.: "Improvement in electroforming equipment for molding plastics" page 468; ref. no. 204909R & GAL'VANOPLAST. PROM-STI, Mater. Semin.1981, 103-5 see abstract	7, 19, 26, 29

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ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO.

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

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